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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	09/787,602
Intl. Filing Date	September 20, 1999
First Named Inventor	Kelly et al.
Group Art Unit	Not Yet Known
PCT Legal Examiner	Not Yet Known
Total Number of Pages in This Submission: 5	Attorney Docket Number: MOT-D2191

ENCLOSURES *(check all that apply)*

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment / Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Assignment Papers *(for an Application)*
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [x] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] After Allowance Communication to Group
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) *(please identify below)*:

SEE REMARKS

Remarks: Exhibits O, P, Q, R and S

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual name	Darryl W. Shorter Reg. No. 47,942 Volpe and Koenig, P.C.
Signature	
Date	January 23, 2002

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: PCT Legal Office, Commissioner for Patents, Washington, DC 20231 on this date: January 23, 2002

Typed or printed name	Darryl W. Shorter		
Signature		Date	January 23, 2002

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the **PATENT APPLICATION** of: Kelly et al. **Application No.:** 09/787,602 **Intl. Filing Date:** September 20, 1999 For: METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS Group: Not Yet Known PCT Legal Examiner: Anthony Smith	Our File: MOT-D2191 Date: January 23, 2002

RENEWED PETITION UNDER 37 C.F.R. § 1.47(a)

PCT Legal Office
Commissioner for Patents
Washington, D.C. 20231

Sir:

This Renewed Petition is being filed in response to the November 27, 2001 Decision on Petition under 37 C.F.R. § 1.47(a) in order to proceed with the above-referenced application without the signature of joint inventor Charles P. Kelly.

In order to comply with item 2 under 37 C.F.R. § 1.47(a), the undersigned sent a letter to Mr. Charles P. Kelly on December 18, 2001 enclosing a complete copy of the application and drawings as filed with the USPTO, as well as the Declaration and Assignment documents forwarded in our previous letters. This December 18, 2001 letter was sent via

certified mail with return receipt requested. A copy of the December 18, 2001 letter and its attachments are enclosed as Exhibit O.

As of January 2, 2002, the undersigned had not received any communication from Mr. Kelly responding to our December 18, 2001 letter. Accordingly, the undersigned sent another letter to Mr. Kelly on January 2, 2002 via FedEx, signature required. FedEx attempted to deliver the package to Mr. Kelly on January 3, 2002, but Mr. Kelly was not available to sign for the package. Therefore, on January 4, 2002 FedEx attempted to redeliver the package to Mr. Kelly at which point a waiver had been signed by someone at Mr. Kelly's address granting FedEx permission to leave the package if no one was home. It appears that the individual that signed the waiver for the package did not want to cooperate and signed the waiver with the name of the undersigned's secretary, Amy McShea, whose name was on the mailing label. Copies of the January 2, 2002 letter, the FedEx Shipment Receipt, and the Track Shipments Detailed Results are enclosed as Exhibits P, Q and R, respectively.

On January 18, 2002 the undersigned received the returned December 18, 2001 certified mailing, indicating that the letter was unclaimed by Mr. Kelly. A copy of the envelope indicating the certified mailing was unclaimed and returned, and the Request for Delivery Information/Return Receipt After Mailing are enclosed as Exhibit S.

The undersigned unsuccessfully also attempted to contact Mr. Kelly by telephone at his last known telephone number: (972) 219-7998.

During a phone conversation with the undersigned on January 11, 2002, Anthony Smith, Attorney-Advisory, PCT Legal Office, indicated that the actions of the undersigned in attempting to contact Mr. Kelly via FedEx and certified mail, enclosing the complete copy of the application and drawings, should be enough to comply with item 2 of § 1.47(a), which had been previously noted as deficient. Mr. Charles P. Kelly's continued refusal to respond to the undersigned, the actions of the person who signed Amy McShea's name on the waiver to receive the January 2, 2002 letter from FedEx, and the failure of Mr. Kelly to return the copy of our letter indicating his refusal to sign the Declaration along with any reasons therefor, further evidences Mr. Kelly's refusal to sign under 37 C.F.R. § 1.47(a).

As of January 22, 2002 , Mr. Kelly has not communicated at all with the undersigned. In view of the above, it is clear that Mr. Kelly is refusing to execute the Declaration and Power of Attorney for the present application, or in the alternative, cannot be reached after diligent effort at his last known address and phone number.

It is respectfully submitted that the undersigned has complied with all required items to proceed without the signature of joint inventor, Charles P. Kelly under 37 C.F.R. § 1.47(a). It is hoped that Mr. Kelly will join in the application at a later date. Therefore, it

is respectfully requested that the Renewed Petition be granted and the PTO accept the application on behalf of signing joint inventor, Mr. Douglas N. Nelson.

Reconsideration and allowance of the pending claims are respectfully requested. If the Examiner believes that a further telephonic interview would facilitate allowance of the claims, she is respectfully requested to contact the undersigned at 215-568-6400.

Respectfully submitted,

Kelly et al.

By _____
Darryl S. Shorter
Registration No. 47,942
(215) 568-6400

Volpe and Koenig, P.C.
Suite 400, One Penn Center
1617 John F. Kennedy Boulevard
Philadelphia, PA 19103

DWS/amc
Enclosures

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BRINGING LAW TO YOUR IDEAS

Darryl W. Shorter
dws@volpe-koenig.com

December 18, 2001

URGENT ACTION REQUIRED

Mr. Charles P. Kelly
2184 Brady Drive
Lewisville, TX 75057

VIA CERTIFIED MAIL
RETURN RECEIPT REQUESTED
7000 1670 0011 8618 1407

Re: *METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS*

Dear Mr. Kelly:

Further to our May 1, May 16, June 4, June 19, July 2, and July 12, 2001 letters regarding the above-identified invention, we have enclosed a complete copy of the application and drawings as filed with the United States Patent and Trademark Office. Also enclosed are the Declaration and Assignment documents we forwarded to you in our previous letters. Please review the application and drawings and sign the Declaration and Assignment where indicated. These documents are required to be filed by **January 27, 2002**. We would appreciate your prompt return of the executed documents or notification that you do not intend to return the documents. For your convenience, we have enclosed a return FedEx envelope.

Please return the original executed documents, in the FedEx envelope provided, as soon as possible, so that we may insure that the documents are filed by the due date.

We look forward to receiving the executed documents. However, if you refuse to sign the Assignment and Declaration documents that are provided herein, please sign and date the copy of this letter which is enclosed herewith as evidence of your refusal. Once you have signed the copy of this letter please return it in the FedEx envelope provided. Please note that even though you refuse to sign, you may subsequently join in the application by filing the aforementioned documents.

Exhibit O

Volpe and Koenig P.C. SM

If you have any questions or require additional information, please do not hesitate to get in contact with us.

Very truly yours,

Volpe and Koenig, P.C.

By _____
Darryl W. Shorter

DWS/amc
Enclosures

cc: Paul F. Bawel, Esquire

Volpe and Koenig P.C.

Suite 400, One Penn Center
1617 John F. Kennedy Boulevard
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BRINGING LAW TO YOUR IDEAS

Darryl W. Shorter
dws@volpe-koenig.com

December 18, 2001

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Mr. Charles P. Kelly
2184 Brady Drive
Lewisville, TX 75057

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Volpe and Koenig P.C.

December 18, 2001

If you have any questions or require additional information, please do not hesitate to get in contact with us.

Very truly yours,

Volpe and Koenig, P.C.

By _____
Darryl W. Shorter

DWS/amc
Enclosures

cc: Paul F. Bawel, Esquire

I hereby refuse to sign the Assignment or Declaration for U.S. Patent Application No. 09/787,602.

_____ _____

Charles P. Kelly Date

U.S. Postal Service
CERTIFIED MAIL RECEIPT
(Domestic Mail Only; No Insurance Coverage Provided)

7000 1670 0011 8618 1407

Postage	$ 2.18
Certified Fee	$ 2.10
Return Receipt Fee (Endorsement Required)	$ 1.50
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MOT-D2191

Sent To
Mr. Charles P. Kelly DWS/amc
Street, Apt. No.; or PO Box No.
2184 Brady Drive
City, State, ZIP+4
Lewisville, TX 75057

PS Form 3800, May 2000 See Reverse for Instructions

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Mr. Charles P. Kelly
2184 Brady Drive
Lewisville, TX 75057

MOT-D2191 DWS/amc

COMPLETE THIS SECTION ON DELIVERY

A. Received by *(Please Print Clearly)* B. Date of Delivery

C. Signature
X ☐ Agent ☐ Addressee

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☒ Certified Mail ☐ Express Mail
☐ Registered ☒ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? *(Extra Fee)* ☐ Yes

2. Article Number *(Copy from service label)*
7000 1670 0011 8618 1407

PS Form 3811, July 1999 Domestic Return Receipt 102595-00-M-0952

METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS

BACKGROUND

This invention is related to encoding and decoding of video information, and more particularly to a method and apparatus for securing the transmission of video signals so that only authorized subscribers can view transmitted video information.

Systems have been developed for scrambling television signals to secure transmission of video information. An example of a scrambling technique involves "block shuffling" wherein a television field consisting of video lines is divided into several blocks or groups of video lines. The video lines within each block are then randomly shuffled or scrambled so that the original line sequence is changed to a new scrambled line sequence within each block. The scrambled video signals are then transmitted to a receiver along with data relating to a code corresponding to the order of the randomly shuffled lines in each block. A receiver having a decoder is utilized at a subscriber location to return the lines within each block to their original sequence so that a video display of each block recreates the original field.

U.S. Patent No. 5,321,748 discloses a method and apparatus for scrambling video signals utilizing such a block shuffling technique. A block of video lines is divided into top and bottom sub block portions. The top and bottom sub block portions are switched and within each sub block portion, the video lines are randomly shuffled. This is said to improve masking of the original video information by increasing the expected value of line displacement.

U.S. Patent No. 4,405,942 discloses another method and system for secure transmission and reception of a video signal wherein parts of the video signal are delayed in relation to each other to form an encoded video signal. The encoder utilizes two field memories and a flip flop such that a first field is loaded into one of the field memories and then before the next field of video information arrives, the flip flop changes state for loading the next field of video information into the second field memory.

Several problems exist in that signal distortion effects occur during transmission. Some of these effects include field tilt or hum caused by cable amplifiers, nonlinear transmitters, or receiver imperfections. These distortion affects may change the luminance of lines in a field. Luminance is typically distorted across the field such that minimal distortion occurs at the top of the field and maximum distortion occurs at the bottom of the field. For example, line 1 may experience a low level of distortion while line 500 experiences a high level of distortion. Since the change in distortion is gradual from the top of the field to the bottom of the field, it is usually not noticeable when a television signal is transmitted and viewed at a subscriber's television. When the lines are shuffled, transmitted, and then deshuffled at a subscriber location, sharp contrasts in luminance between adjacent deshuffled lines may be visible on the video display. This occurs because the shuffled field is transmitted and the gradual distortion effect described above is applied during the transmission. During deshuffling, a line which was transmitted at position 1 with a low level of distortion may be moved next to a line which was transmitted at position

500 having a high level of distortion creating an undesirable effect which is visible in the television picture received at the subscriber location. This problem is exaggerated by increasing the average expected line displacement during the shuffling process. Therefore, the maximum average line displacement will be limited by the transmission network causing the distortion. For example, a network having high distortion can accommodate a smaller average line displacement than a network having lower distortion. Since increasing average line displacement improves masking, it is therefore desirable to transmit scrambled signals having the maximum average line displacement which network distortion permits.

Another problem exists in that systems for encoding or decoding the video signals typically utilize a plurality of memories for processing. This increases the number of components necessary to implement such a system and also introduces unwanted delay in signal processing.

SUMMARY

It is therefore an object of the present invention to provide a method and apparatus for scrambling and descrambling video signals utilizing a shuffling technique which is adaptable to a given network for maximizing masking of the video signal while minimizing undesirable effects of network distortion.

It is a further object of the invention to implement such a system in order to minimize the number of memory components and delay in signal processing.

These and other objects have been achieved by providing a method for video line shuffling wherein a picture field containing a plurality of lines is first applied to a shuffling function having a first block size parameter and a first increment parameter. Next, the shuffled lines are applied to a second shuffling function having a second block size parameter and a second increment parameter. Memory requirements are reduced in the deshuffling method by utilizing a single memory and writing to locations in that memory in a step immediately following a read from the respective locations. Where the memory device utilized is a DRAM, a method is presented for refreshing rows and columns of the DRAM without the need for strobing.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block representation of the shuffling and deshuffling process.

Figure 2 is a diagram of a recursive function for shuffling or deshuffling lines of a video field.

Figure 3 is a graph showing input line number versus output line number for a first shuffling method.

Figure 4 is a graph showing input line number versus output line number for a second shuffling method.

Figure 5 is a diagram of a video shuffling method having reduced memory requirements.

Figure 6 is a table showing memory write locations for a series of video line samples.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The video line shuffling method will first be described generally with reference to **Figure 1.** A shuffler first applies a permutation **P** to an original picture **10**. The permutation **P** rearranges the line sequence of the original picture **10** to form a shuffled picture **20**. The shuffled picture **20** is considered to be masked or secure because if viewed on a monitor or television, the original picture **10** is unintelligible.

The shuffled picture **20** is transmitted over a network to a set top terminal having a deshuffler for reconstructing the original picture **10**. The deshuffler serves to apply an inverse permutation $\mathbf{P^{-1}}$ to the shuffled picture **20** to create a reconstructed picture **10'**. The deshuffler having the inverse permutation $\mathbf{P^{-1}}$ rearranges the shuffled lines into their original positions to reconstruct the original picture.

The shuffling method will now be described in greater detail with reference to **Figure 2**. The permutation **P** is defined by a series of shuffling functions g(x). Each shuffling function g(x) is defined by a pair of shuffle parameters (B, I) where the B values correspond to a block size and the I values correspond to an increment within the block. Therefore, if the line number, x is known, each shuffling function can be described by:

g(x,B,I)

To complete the permutation, a series of shuffling functions may be applied to the original picture **10**. **Figure 2**, for example, shows the application of three such shuffling functions resulting in the permutation defined by:

g(g(g(x,B1,I1),B2,I2),B3,I3)

where x is the original line number of a given line in a field, **Bn** is a parameter defining the block size for a respective shuffling function **n**, and **In** is a parameter defining an increment within the blocks for the respective shuffling function **n**. Following a line, for example line 1, through the permutation, it can be seen that line 1 enters the first shuffling function and exits at position 4. It then exits the second shuffling function at position 9 and exits the third shuffling function at position 12. The inverse permutation $\mathbf{P}^{-1}$ is represented by a reverse path traveling from the right to left side of **Figure 2**. It should be understood that B and I values can be selected to achieve a number of different permutations **P** and inverse permutations $\mathbf{P}^{-1}$. By selecting B and I values the permutation **P** can be designed to limit line displacement. For example, in **Figure 2**, B1, B2 and B3are selected so that the resultant blocks have coincident boundaries **H1, H2, H3** at the center of each shuffling function. The result is that no line will cross the center of the permutation **P** thus limiting maximum line displacement to within on half of the picture **10**.

Referring now to **Figures 3** and **4**, results data will be described for two different permutations applied by the shuffler of **Figure 1**. It should be understood that these permutations are shown to illustrate how masking is limited by system

distortion. Also, these permutations are different from the permutation presented in **Figure 2**. **Figure 3** shows a graphical representation of input line versus output line numbers for a first selected permutation **P**. The resultant pattern indicates that each line of the original picture **10** is moved only a small amount in the shuffle picture **20**. This permutation is desirable for systems that have high levels of distortion introduced during transmission. The reconstructed picture **10'** will exhibit only minor distortion upon reconstruction. This permutation, however, provides a low level of masking since the lines are shuffled in a pattern along a relatively small displacement.

Figure 4 shows a graphical representation of input line versus output line number for a second permutation **P**. This permutation, exhibits a high level of line displacement and is suitable for systems containing less distortion. It can be appreciated that this permutation provides a higher degree of masking since lines are displaced more than the those of **Figure 3**.

Video line shuffling/deshuffling methods require the use of memory, typically random access memory (RAM), for temporarily storing and reading lines during permutation. Since reducing the number of components in such a system often reduces the cost, it is desirable to minimize the amount of memory necessary for performing the shuffling and deshuffling method. Additionally, memory typically represents a large percentage of the cost associated with a finished terminal containing the deshuffler. As described in the background section, known techniques utilize a pair of memories, one memory typically is written to in a cycle

while the other memory is typically read from in order to perform the deshuffling. **Figure 5** shows a method of deshuffling utilizing an exemplary single four location memory. It should be understood that while a four location memory is utilized in this example in order to simplify the explanation, smaller or larger memories can be utilized with this method. Also, for ease of explanation, a simplified permutation **M** and inverse permutation $\mathbf{M}^{-1}$ will be described. Those reasonably skilled in the art will appreciate that a more complex permutation such as that shown in **Figure 2** could be applied to this method. The memory which will be described is located within a decoder which is typically part of a set top terminal at a subscriber location. The shuffler is typically positioned at the head end of a video transmission system.

Beginning at the upper left corner of **Figure 5**, in the first step, an original line sequence of 1, 2, 3, 4 has been stored in the memory. A deshuffler reads the memory in order such that 1 is read from the first position. Next, the shuffler sends a permutation 2, 3, 1, 4 which is stored in consecutive memory locations as shown in steps 2-5. Also during this second step, the deshuffler continues to read from the memory in order such that the second, third and fourth locations are read. During the fifth step, the deshuffler does not read from the memory. This is because between steps 5 and 6, the Verticle Blanking Interval (VBI) occurs. This is shown by way of example to illustrate how an interval is provided between steps for the VBI. Those skilled in the art will appreciate that while the VBI is shown between steps 5 and 6 and again between steps 10 and 1, the method can be adapted to provide this interval between different steps according to timing requirements of any

given system. In step 6, the deshuffler reads from memory locations utilizing the inverse permutation 3, 1, 2, 4. In step 7 the shuffler begins consecutively storing according to the inverse permutation 3, 1, 2, 4. It should be noticed that in each step where the shuffler stores a value into a memory location, the deshuffler in the previous step has read from that same location. Therefore, each memory location is utilized as soon as it is made available by having been read from It should be noted that the shuffler sends the inverse permutation M^{-1} based upon the location number of the most recently read data in steps 6-10. For example in step 6, a 1 is read from location 3, therefore in step 7, the shuffler sends a 3 corresponding to the location number previously read. In step 7 the deshuffler reads 2 from location 1, therefore the shuffler sends a 1 corresponding to the location number previously read. Based upon this logic, the inverse permutation 3, 1, 2, 4 is generated.

Another method of reducing cost of the finished terminal is to select lower cost memory components. For example, DRAM may be suitable from economic and design requirements perspectives. The use of DRAM as a memory device for the deshuffler and a novel write method will now be described in greater detail with reference to **Figure 6**. First it should be understood that each line of video is digitally sampled for storage in the memory. In this example, 909 samples are taken per line. It should also be understood that the number of samples may be selected according to system design requirements. DRAM is typically arranged to have locations in rows and columns. In order to refresh a row of DRAM, it is necessary to either write to or strobe any column in that row. Likewise, in order to refresh any

column, it is necessary to write to or strobe any row along that column. It is necessary to refresh all rows and columns at a minimum time interval prescribed by the DRAM. In this case, the refresh rate for the selected DRAM is 8 ms. Since DRAM is required to have its columns and rows refreshed at the refresh rate, they are typically strobed to maintain the data stored in locations in the associated rows and columns. A problem is presented in that strobing requires added bandwidth to send the strobe signals. The following method eliminates the need for the strobe signals and therefore reduces bandwidth requirements. Write locations are selected in such a way that rows and columns are written to within a minimum time interval prescribed by the refresh rate to avoid losing data stored therein and to avoid the need to strobing the rows or columns.

Referring now to **Figure 6**, the storage of 909 samples representing video line 0 will be described.. The first 127 samples are written into row 0. Along row 0 of the DRAM, the samples are written into columns 0 through 127. The samples 128-255 are next written into row 64, columns 128-225. This pattern continues until sample 512. The particular DRAM selected for this application utilizes a nine bit column address having a maximum value of 511. Continuing along video line 0, samples 512-639 are written into row 256, columns 0-127. It is therefore evident that the column numbers wrap back to 0 after reaching the maximum value of 511. Continuing along video line 0, samples 640-767 are written into row 320, columns 128-255. Samples are written at an approximate rate of 14 million samples per second. This allows 128 lines of 909 samples to be written into DRAM every 8 ms.

With each line being written according to **Figure 6**, this method serves to refresh each column and each row within the given time interval necessary for the DRAM.

An advantage of the present invention is that the shuffling method provides a controlled amount of maximum line displacement which is adjustable depending upon the distortion present in a given system. This provides for a maximum masking level within the confines of system distortion.

An additional advantage is that one memory may be utilized to deshuffle a shuffled picture.

An additional advantage is that where DRAM is utilized for the memory, the need for strobing or refreshing the memory is eliminated.

It should be understood that while this invention is presented here in the form of the embodiments shown, the scope of the invention is intended to be limited only by the following claims.

What is claimed is:

1. A video line shuffling method comprising the steps of:

applying a first shuffling function to a plurality of lines, the first shuffling function having a first block size parameter and a first increment parameter;

applying a second shuffling function to the plurality of lines, the second shuffling function having a second block size parameter and a second increment parameter.

2. The video line shuffling method of claim 1 wherein line displacement in each shuffling function is limited to be within a block defined by the respective block size parameters.

3. The video line shuffling method of claim 2 wherein line displacement within each block is limited by the increment parameter.

4. The video line shuffling method of claim 1 further comprising the step of applying a third shuffling function to the plurality of lines, the third shuffling function having a third block size parameter and a third increment parameter.

5. The video line shuffling method of claim 4 further comprising the step of applying a series of shuffling functions to the plurality of lines, the series containing

at least one shuffling function having a respective block size parameter and a respective increment parameter.

6. The video line shuffling method of any one of claims 1 to 5 wherein the block size parameter of one of the shuffling functions defines a block having at least one boundary coincident with a boundary of a block of another shuffling function.

7. A video line shuffling method utilizing a shuffler at a first location and a deshuffler having a memory at a second location, the method comprising the steps of:

sending a first series of data shuffled according to a first permutation from the shuffler to the deshuffler;

sequentially writing the first series of data into the memory such that data is written into a memory location immediately after that memory location has been read,

sending a second series of data according to an inverse of the first permutation from the shuffler to the deshuffler; and

writing to memory locations defined by the data in the inverse permutation such that data is written into a memory location immediately after that memory location has been read.

8. A method of writing data into a memory having C columns and R rows defining a plurality of memory locations, the method comprising the steps of:

dividing the data into lines wherein each line contains a first length of data;

dividing the lines into subsets each having a second length being smaller that the first length;

writing each subset into a selected row and column range of the memory such that each time a subset is written, the selected row is incremented by a value I.

9. The method of claim 8 wherein I is selected so that each row has data written therein within a minimum selected time interval.

* * *

ABSTRACT

This invention teaches a video line shuffling method wherein video line displacement is variable and controlled depending upon the distortion in a given system. A series of permutations is applied to the original picture such that lines are shuffled in a controlled manner to achieve line displacement within a desired range. Memory requirements are minimized by utilizing a method whereby a single memory has data written into locations which were read from in a previous step. Where DRAM is utilized for the memory, a write method is employed to eliminate the need for strobing the rows and columns DRAM.

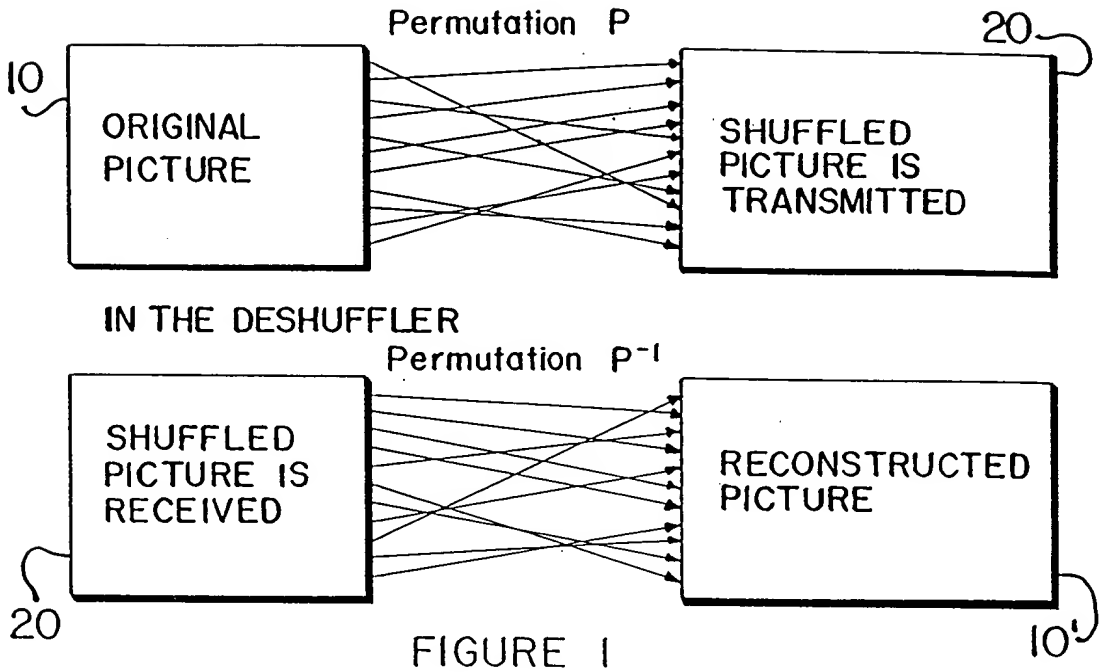
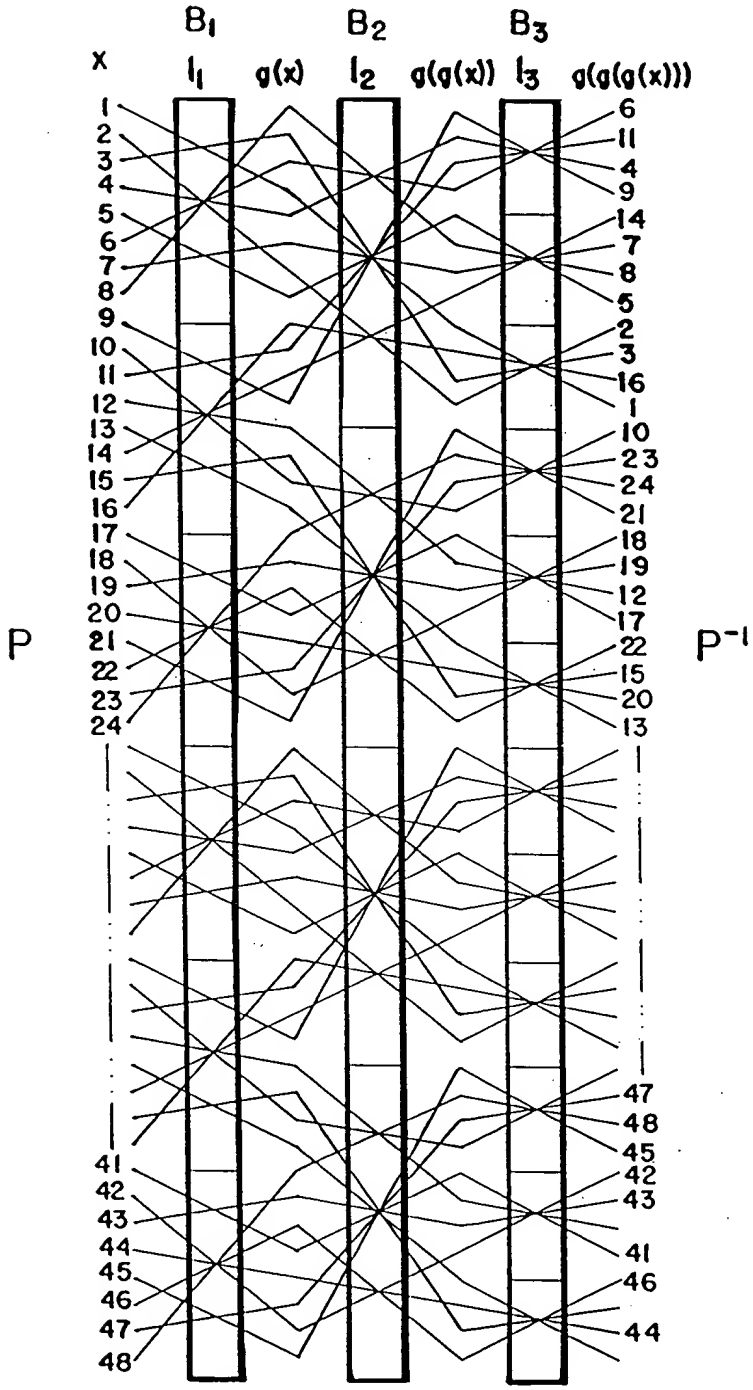

IN THE SHUFFLER:
Permutation P
10
ORIGINAL PICTURE
SHUFFLED PICTURE IS TRANSMITTED
20
IN THE DESHUFFLER
Permutation P^{-1}
SHUFFLED PICTURE IS RECEIVED
20
RECONSTRUCTED PICTURE
10'

FIGURE 1



$g(g(g(x,B_1,I_1),B_2I_2),B_3B_3)$

FIGURE 2

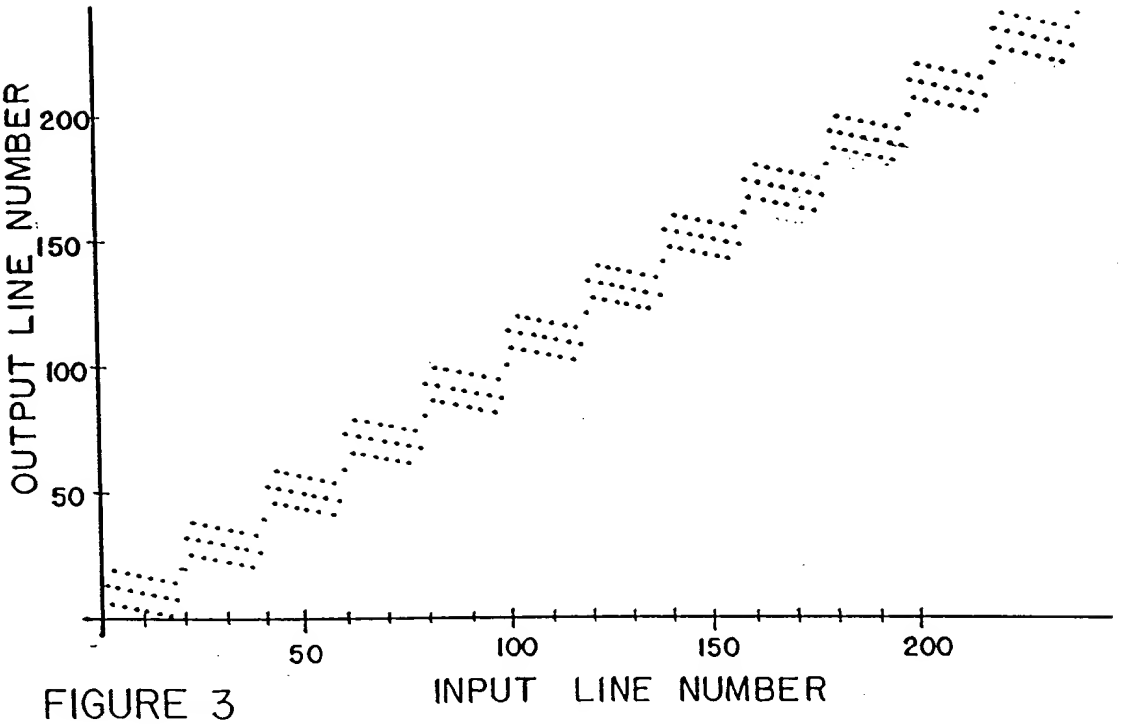


FIGURE 3

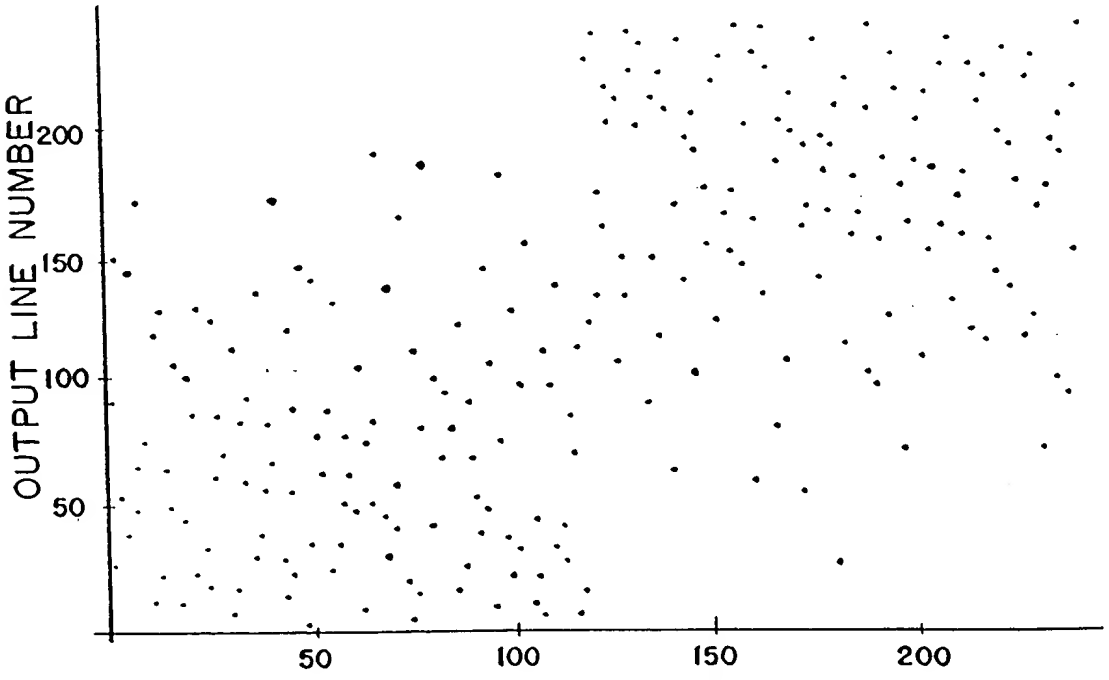


FIGURE 4

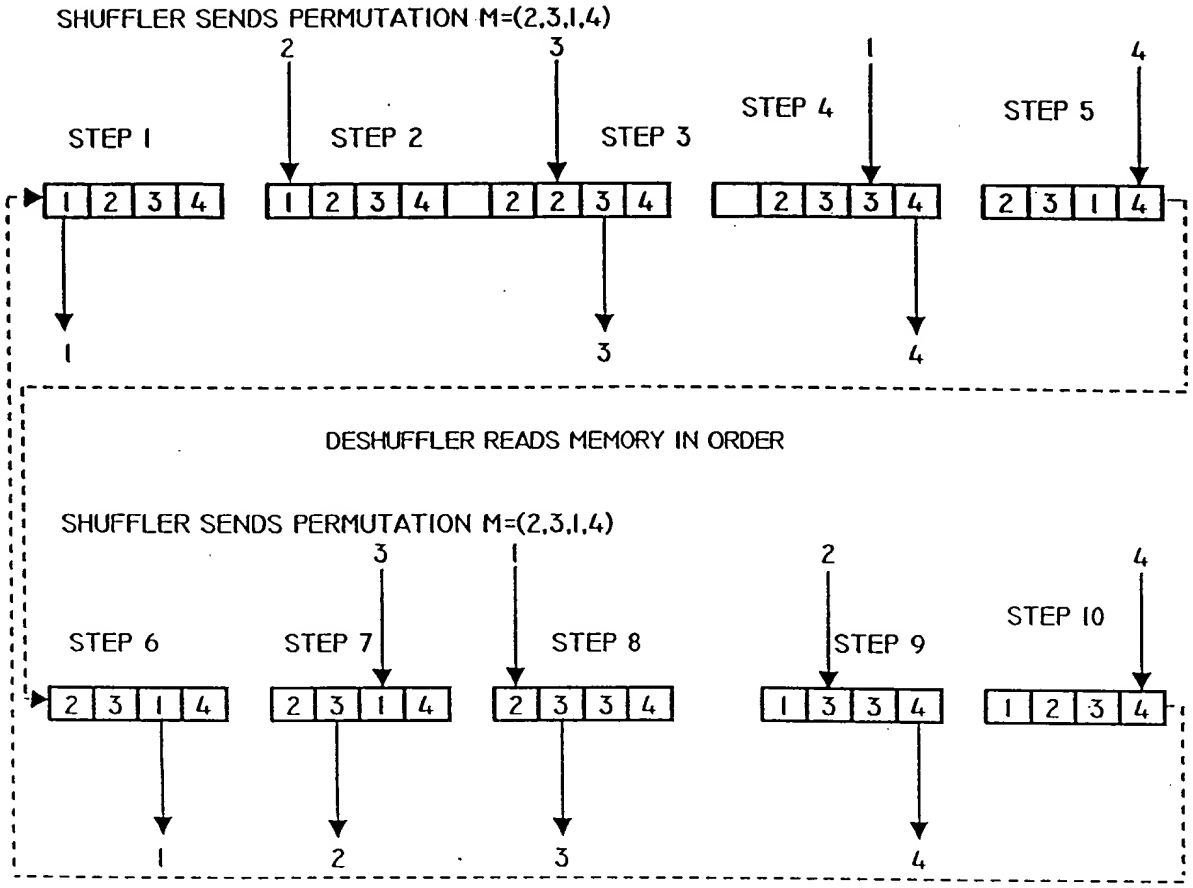


FIGURE 5

VIDEO LINE	ROW DURING SAMPLES							
	0-127	128-255	256-383	384-511	512-639	640-767	768-895	896-908
0	0	64	128	192	256	320	384	448
1	1	65	129	193	257	321	385	449
2	2	66	130	194	258	322	386	450
3	3	67	131	195	259	323	387	451
4	4	68	132	196	260	324	388	452
...	...	...	...	...	...	...	...	...
63	63	127	191	255	319	383	447	511
64	64	128	192	256	320	384	448	0
65	65	129	193	257	321	385	449	1
66	66	130	194	258	322	386	450	2
67	67	131	195	259	323	387	451	3
...	...	...	...	...	...	...	...	...
N	N	(N+64) %512	(N+128) %512	(N+192) %512	(N+256) %512	(N+320) %512	(N+384) %512	(N+448) %512

FIGURE 6

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	MOT-D2191
First Named Inventor	Kelly et al.
COMPLETE IF KNOWN	
Application Number	09/787,602
Filing Date	Not Yet Known
Group Art Unit	Not Yet Known
Examiner Name	Not Yet Known

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS

(Title of the Invention)

the specification of which
☐ is attached hereto
OR
☒ was filed on (MM/DD/YYYY) 09/20/1999 as United States Application Number or PCT International Application Number PCT/US99/21666 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
		☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Washington, DC 20231.

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)
PCT/US99/21666	09/20/1999	

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☒ Customer Number 24375 → *Place Customer Number Bar Code Label here*
OR
☐ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
Namely, the Attorneys of Volpe and Koenig, P.C.			

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number or Bar Code Label 24375 *OR* ☐ Correspondence address below

Name	VOLPE AND KOENIG, P.C. DEPT MOT				
Address					
Address					
City		State		ZIP	
Country		Telephone		Fax	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Charles P.	Kelly

Inventor's Signature						Date	
Residence: City	The Colony	State	TX	Country	USA	Citizenship	USA
Post Office Address	4905 Colony Blvd. N						
Post Office Address							
City	The Colony	State	TX	ZIP	75056	Country	USA

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 1 of 1

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Douglas N.	Nelson		
Inventor's Signature			**Date**
Residence: City Plano	**State** TX	**Country** USA	**Citizenship** USA
Mailing Address 7001 West Parker			
Mailing Address Apartment 1617			
City Plano	**State** TX	**ZIP** 75093	**Country** USA

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
Mailing Address			
Mailing Address			
City	**State**	**ZIP**	**Country**

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
Mailing Address			
Mailing Address			
City	**State**	**ZIP**	**Country**

Atty. Docket No. MOT-D2191

ASSIGNMENT

WHEREAS, Charles P. Kelly, residing at 4905 Colony Blvd N, The Colony, TX 75056, United States of America; and Douglas N. Nelson, residing at 7001 West Parker, Apartment 1617, Plano, TX 75093, United States of America, both citizens of the United States of America (hereafter jointly and severally referred to as the undersigned), are the inventors of METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS, for which the undersigned have executed an application for United States Letters Patent, U.S. Patent Application No. 09/787,602, which is the U.S. National Phase Application of International Application No. PCT/US99/21666; filed September 20, 1999.

The undersigned hereby authorize assignee or assignee's representative to insert the Application Number and the filing date of this application if they are unknown at the time of execution of this assignment.

AND, WHEREAS, General Instrument Corporation, a Delaware corporation, having its principal place of business at 101 Tournament Drive, Horsham, PA 19044, United States of America (hereafter referred to as the assignee), is desirous of acquiring the entire right, title and interest in said invention, all applications for and all letters patent issued on said invention.

NOW, THEREFORE, in consideration of One Dollar ($1.00), receipt of which is acknowledged by the undersigned, and of other good and valuable consideration, the undersigned, intending to be legally bound, do hereby sell, assign and transfer to the assignee

and assignee's successors, assigns and legal representatives the entire right, title and interest in said invention and all patent applications thereon, including, but not limited to, the application for United States Letters Patent entitled as above, and all divisions and continuations thereof, and in all letters patent, including all reissues thereof, throughout the world, including the right to claim priority under the Paris Convention.

It is agreed that the undersigned shall be legally bound, upon request of the assignee, to supply all information and evidence relating to the making and practice of said invention, to testify in any legal proceeding relating thereto, to execute all instruments proper to patent the invention throughout the world for the benefit of the assignee, and to execute all instruments proper to carry out the intent of this instrument.

The undersigned warrant that the rights and property herein conveyed are free and clear of any encumbrance.

EXECUTED under seal on this _____ day of _____, 2001

at _____.

Witness:

_____ _____

(L.S.) Charles P. Kelly

State of _____

ss.

County of _____

On this ___ day of _____, 2001 before me personally appeared Charles P. Kelly, to me known to be the persons described herein and who executed the foregoing instrument, and acknowledged that he executed the same knowingly and willingly and for the purposes therein contained.

Witness my hand and Notarial seal the day and year immediately above written.

_____

Notary Public

My Commission Expires:

EXECUTED under seal on this _____ day of _____, 2001

at _____.

Witness:

_____ _____

(L.S.) Douglas N. Nelson

State of _____

ss.

County of _____

On this __ day of _____, 2001 before me personally appeared Douglas N. Nelson, to me known to be the persons described herein and who executed the foregoing instrument, and acknowledged that he executed the same knowingly and willingly and for the purposes therein contained.

Witness my hand and Notarial seal the day and year immediately above written.

_____

Notary Public

My Commission Expires:

Volpe and Koenig P.C.SM

Suite 400, One Penn Center
1617 John F. Kennedy Boulevard
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BRINGING LAW TO YOUR IDEAS

Darryl W. Shorter
dws@volpe-koenig.com

January 2, 2002

URGENT ACTION REQUIRED

Mr. Charles P. Kelly
2184 Brady Drive
Lewisville, TX 75057

Via FedEx

Re: *METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS*

Dear Mr. Kelly:

Further to our December 18, May 1, May 16, June 4, June 19, July 2, and July 12, 2001 letters regarding the above-identified invention, we have enclosed a complete copy of the application and drawings as filed with the United States Patent and Trademark Office. Also enclosed are the Declaration and Assignment documents we forwarded to you in our previous letters. Please review the application and drawings and sign the Declaration and Assignment where indicated. These documents are required to be filed by **January 27, 2002**. We would appreciate your prompt return of the executed documents or notification that you do not intend to return the documents. For your convenience, we have enclosed a return FedEx envelope.

Please return the original executed documents, in the FedEx envelope provided by **January 10, 2002**, so that we may insure that the documents are filed by the due date.

We look forward to receiving the executed documents. However, if you refuse to sign the Assignment and Declaration documents that are provided herein, please sign and date the copy of this letter which is enclosed herewith as evidence of your refusal. Once you have signed the copy of this letter please return it in the FedEx envelope provided. Please note that even though you refuse to sign, you may subsequently join in the application by filing the aforementioned documents.

Exhibit P

Volpe and Koenig P.C.

If you have any questions or require additional information, please do not hesitate to get in contact with us.

Very truly yours,

Volpe and Koenig, P.C.

By
Darryl W. Shorter

DWS/amc
Enclosures

Volpe and Koenig P.C.SM

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BRINGING LAW TO YOUR IDEAS

Darryl W. Shorter
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Volpe and Koenig P.C.

January 2, 2002

If you have any questions or require additional information, please do not hesitate to get in contact with us.

Very truly yours,

Volpe and Koenig, P.C.

By
Darryl W. Shorter

DWS/amc
Enclosures

I hereby refuse to sign the Assignment or Declaration for U.S. Patent Application No. 09/787,602.

Charles P. Kelly

Date

METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS

BACKGROUND

This invention is related to encoding and decoding of video information, and more particularly to a method and apparatus for securing the transmission of video signals so that only authorized subscribers can view transmitted video information.

Systems have been developed for scrambling television signals to secure transmission of video information. An example of a scrambling technique involves "block shuffling" wherein a television field consisting of video lines is divided into several blocks or groups of video lines. The video lines within each block are then randomly shuffled or scrambled so that the original line sequence is changed to a new scrambled line sequence within each block. The scrambled video signals are then transmitted to a receiver along with data relating to a code corresponding to the order of the randomly shuffled lines in each block. A receiver having a decoder is utilized at a subscriber location to return the lines within each block to their original sequence so that a video display of each block recreates the original field.

U.S. Patent No. 5,321,748 discloses a method and apparatus for scrambling video signals utilizing such a block shuffling technique. A block of video lines is divided into top and bottom sub block portions. The top and bottom sub block portions are switched and within each sub block portion, the video lines are randomly shuffled. This is said to improve masking of the original video information by increasing the expected value of line displacement.

U.S. Patent No. 4,405,942 discloses another method and system for secure transmission and reception of a video signal wherein parts of the video signal are delayed in relation to each other to form an encoded video signal. The encoder utilizes two field memories and a flip flop such that a first field is loaded into one of the field memories and then before the next field of video information arrives, the flip flop changes state for loading the next field of video information into the second field memory.

Several problems exist in that signal distortion effects occur during transmission. Some of these effects include field tilt or hum caused by cable amplifiers, nonlinear transmitters, or receiver imperfections. These distortion affects may change the luminance of lines in a field. Luminance is typically distorted across the field such that minimal distortion occurs at the top of the field and maximum distortion occurs at the bottom of the field. For example, line 1 may experience a low level of distortion while line 500 experiences a high level of distortion. Since the change in distortion is gradual from the top of the field to the bottom of the field, it is usually not noticeable when a television signal is transmitted and viewed at a subscriber's television. When the lines are shuffled, transmitted, and then deshuffled at a subscriber location, sharp contrasts in luminance between adjacent deshuffled lines may be visible on the video display. This occurs because the shuffled field is transmitted and the gradual distortion effect described above is applied during the transmission. During deshuffling, a line which was transmitted at position 1 with a low level of distortion may be moved next to a line which was transmitted at position

500 having a high level of distortion creating an undesirable effect which is visible in the television picture received at the subscriber location. This problem is exaggerated by increasing the average expected line displacement during the shuffling process. Therefore, the maximum average line displacement will be limited by the transmission network causing the distortion. For example, a network having high distortion can accommodate a smaller average line displacement than a network having lower distortion. Since increasing average line displacement improves masking, it is therefore desirable to transmit scrambled signals having the maximum average line displacement which network distortion permits.

Another problem exists in that systems for encoding or decoding the video signals typically utilize a plurality of memories for processing. This increases the number of components necessary to implement such a system and also introduces unwanted delay in signal processing.

SUMMARY

It is therefore an object of the present invention to provide a method and apparatus for scrambling and descrambling video signals utilizing a shuffling technique which is adaptable to a given network for maximizing masking of the video signal while minimizing undesirable effects of network distortion.

It is a further object of the invention to implement such a system in order to minimize the number of memory components and delay in signal processing.

These and other objects have been achieved by providing a method for video line shuffling wherein a picture field containing a plurality of lines is first applied to a shuffling function having a first block size parameter and a first increment parameter. Next, the shuffled lines are applied to a second shuffling function having a second block size parameter and a second increment parameter. Memory requirements are reduced in the deshuffling method by utilizing a single memory and writing to locations in that memory in a step immediately following a read from the respective locations. Where the memory device utilized is a DRAM, a method is presented for refreshing rows and columns of the DRAM without the need for strobing.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block representation of the shuffling and deshuffling process.

Figure 2 is a diagram of a recursive function for shuffling or deshuffling lines of a video field.

Figure 3 is a graph showing input line number versus output line number for a first shuffling method.

Figure 4 is a graph showing input line number versus output line number for a second shuffling method.

Figure 5 is a diagram of a video shuffling method having reduced memory requirements.

Figure 6 is a table showing memory write locations for a series of video line samples.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The video line shuffling method will first be described generally with reference to **Figure 1.** A shuffler first applies a permutation **P** to an original picture **10**. The permutation **P** rearranges the line sequence of the original picture **10** to form a shuffled picture **20**. The shuffled picture **20** is considered to be masked or secure because if viewed on a monitor or television, the original picture **10** is unintelligible.

The shuffled picture **20** is transmitted over a network to a set top terminal having a deshuffler for reconstructing the original picture **10**. The deshuffler serves to apply an inverse permutation $\mathbf{P^{-1}}$ to the shuffled picture **20** to create a reconstructed picture **10'**. The deshuffler having the inverse permutation $\mathbf{P^{-1}}$ rearranges the shuffled lines into their original positions to reconstruct the original picture.

The shuffling method will now be described in greater detail with reference to **Figure 2**. The permutation **P** is defined by a series of shuffling functions g(x). Each shuffling function g(x) is defined by a pair of shuffle parameters (B, I) where the B values correspond to a block size and the I values correspond to an increment within the block. Therefore, if the line number, x is known, each shuffling function can be described by:

g(x,B,I)

To complete the permutation, a series of shuffling functions may be applied to the original picture **10**. **Figure 2**, for example, shows the application of three such shuffling functions resulting in the permutation defined by:

g(g(g(x,B1,I1),B2,I2),B3,I3)

where x is the original line number of a given line in a field, **Bn** is a parameter defining the block size for a respective shuffling function **n**, and **In** is a parameter defining an increment within the blocks for the respective shuffling function **n**. Following a line, for example line 1, through the permutation, it can be seen that line 1 enters the first shuffling function and exits at position 4. It then exits the second shuffling function at position 9 and exits the third shuffling function at position 12. The inverse permutation $\mathbf{P}^{-1}$ is represented by a reverse path traveling from the right to left side of **Figure 2**. It should be understood that B and I values can be selected to achieve a number of different permutations **P** and inverse permutations $\mathbf{P}^{-1}$. By selecting B and I values the permutation **P** can be designed to limit line displacement. For example, in **Figure 2**, B1, B2 and B3are selected so that the resultant blocks have coincident boundaries **H1, H2, H3** at the center of each shuffling function. The result is that no line will cross the center of the permutation **P** thus limiting maximum line displacement to within on half of the picture **10**.

Referring now to **Figures 3** and **4**, results data will be described for two different permutations applied by the shuffler of **Figure 1**. It should be understood that these permutations are shown to illustrate how masking is limited by system

distortion. Also, these permutations are different from the permutation presented in **Figure 2**. **Figure 3** shows a graphical representation of input line versus output line numbers for a first selected permutation **P**. The resultant pattern indicates that each line of the original picture **10** is moved only a small amount in the shuffle picture **20**. This permutation is desirable for systems that have high levels of distortion introduced during transmission. The reconstructed picture **10'** will exhibit only minor distortion upon reconstruction. This permutation, however, provides a low level of masking since the lines are shuffled in a pattern along a relatively small displacement.

Figure 4 shows a graphical representation of input line versus output line number for a second permutation **P**. This permutation, exhibits a high level of line displacement and is suitable for systems containing less distortion. It can be appreciated that this permutation provides a higher degree of masking since lines are displaced more than the those of **Figure 3**.

Video line shuffling/deshuffling methods require the use of memory, typically random access memory (RAM), for temporarily storing and reading lines during permutation. Since reducing the number of components in such a system often reduces the cost, it is desirable to minimize the amount of memory necessary for performing the shuffling and deshuffling method. Additionally, memory typically represents a large percentage of the cost associated with a finished terminal containing the deshuffler. As described in the background section, known techniques utilize a pair of memories, one memory typically is written to in a cycle

while the other memory is typically read from in order to perform the deshuffling. **Figure 5** shows a method of deshuffling utilizing an exemplary single four location memory. It should be understood that while a four location memory is utilized in this example in order to simplify the explanation, smaller or larger memories can be utilized with this method. Also, for ease of explanation, a simplified permutation **M** and inverse permutation $\mathbf{M}^{-1}$ will be described. Those reasonably skilled in the art will appreciate that a more complex permutation such as that shown in **Figure 2** could be applied to this method. The memory which will be described is located within a decoder which is typically part of a set top terminal at a subscriber location. The shuffler is typically positioned at the head end of a video transmission system.

Beginning at the upper left corner of **Figure 5**, in the first step, an original line sequence of 1, 2, 3, 4 has been stored in the memory. A deshuffler reads the memory in order such that 1 is read from the first position. Next, the shuffler sends a permutation 2, 3, 1, 4 which is stored in consecutive memory locations as shown in steps 2-5. Also during this second step, the deshuffler continues to read from the memory in order such that the second, third and fourth locations are read. During the fifth step, the deshuffler does not read from the memory. This is because between steps 5 and 6, the Verticle Blanking Interval (VBI) occurs. This is shown by way of example to illustrate how an interval is provided between steps for the VBI. Those skilled in the art will appreciate that while the VBI is shown between steps 5 and 6 and again between steps 10 and 1, the method can be adapted to provide this interval between different steps according to timing requirements of any

given system. In step 6, the deshuffler reads from memory locations utilizing the inverse permutation 3, 1, 2, 4. In step 7 the shuffler begins consecutively storing according to the inverse permutation 3, 1, 2, 4. It should be noticed that in each step where the shuffler stores a value into a memory location, the deshuffler in the previous step has read from that same location. Therefore, each memory location is utilized as soon as it is made available by having been read from It should be noted that the shuffler sends the inverse permutation M^{-1} based upon the location number of the most recently read data in steps 6-10. For example in step 6, a 1 is read from location 3, therefore in step 7, the shuffler sends a 3 corresponding to the location number previously read. In step 7 the deshuffler reads 2 from location 1, therefore the shuffler sends a 1 corresponding to the location number previously read. Based upon this logic, the inverse permutation 3, 1, 2, 4 is generated.

Another method of reducing cost of the finished terminal is to select lower cost memory components. For example, DRAM may be suitable from economic and design requirements perspectives. The use of DRAM as a memory device for the deshuffler and a novel write method will now be described in greater detail with reference to **Figure 6**. First it should be understood that each line of video is digitally sampled for storage in the memory. In this example, 909 samples are taken per line. It should also be understood that the number of samples may be selected according to system design requirements. DRAM is typically arranged to have locations in rows and columns. In order to refresh a row of DRAM, it is necessary to either write to or strobe any column in that row. Likewise, in order to refresh any

column, it is necessary to write to or strobe any row along that column. It is necessary to refresh all rows and columns at a minimum time interval prescribed by the DRAM. In this case, the refresh rate for the selected DRAM is 8 ms. Since DRAM is required to have its columns and rows refreshed at the refresh rate, they are typically strobed to maintain the data stored in locations in the associated rows and columns. A problem is presented in that strobing requires added bandwidth to send the strobe signals. The following method eliminates the need for the strobe signals and therefore reduces bandwidth requirements. Write locations are selected in such a way that rows and columns are written to within a minimum time interval prescribed by the refresh rate to avoid losing data stored therein and to avoid the need to strobing the rows or columns.

Referring now to **Figure 6**, the storage of 909 samples representing video line 0 will be described.. The first 127 samples are written into row 0. Along row 0 of the DRAM, the samples are written into columns 0 through 127. The samples 128-255 are next written into row 64, columns 128-225. This pattern continues until sample 512. The particular DRAM selected for this application utilizes a nine bit column address having a maximum value of 511. Continuing along video line 0, samples 512-639 are written into row 256, columns 0-127. It is therefore evident that the column numbers wrap back to 0 after reaching the maximum value of 511. Continuing along video line 0, samples 640-767 are written into row 320, columns 128-255. Samples are written at an approximate rate of 14 million samples per second. This allows 128 lines of 909 samples to be written into DRAM every 8 ms.

With each line being written according to **Figure 6**, this method serves to refresh each column and each row within the given time interval necessary for the DRAM.

An advantage of the present invention is that the shuffling method provides a controlled amount of maximum line displacement which is adjustable depending upon the distortion present in a given system. This provides for a maximum masking level within the confines of system distortion.

An additional advantage is that one memory may be utilized to deshuffle a shuffled picture.

An additional advantage is that where DRAM is utilized for the memory, the need for strobing or refreshing the memory is eliminated.

It should be understood that while this invention is presented here in the form of the embodiments shown, the scope of the invention is intended to be limited only by the following claims.

What is claimed is:

1. A video line shuffling method comprising the steps of:

applying a first shuffling function to a plurality of lines, the first shuffling function having a first block size parameter and a first increment parameter;

applying a second shuffling function to the plurality of lines, the second shuffling function having a second block size parameter and a second increment parameter.

2. The video line shuffling method of claim 1 wherein line displacement in each shuffling function is limited to be within a block defined by the respective block size parameters.

3. The video line shuffling method of claim 2 wherein line displacement within each block is limited by the increment parameter.

4. The video line shuffling method of claim 1 further comprising the step of applying a third shuffling function to the plurality of lines, the third shuffling function having a third block size parameter and a third increment parameter.

5. The video line shuffling method of claim 4 further comprising the step of applying a series of shuffling functions to the plurality of lines, the series containing

at least one shuffling function having a respective block size parameter and a respective increment parameter.

6. The video line shuffling method of any one of claims 1 to 5 wherein the block size parameter of one of the shuffling functions defines a block having at least one boundary coincident with a boundary of a block of another shuffling function.

7. A video line shuffling method utilizing a shuffler at a first location and a deshuffler having a memory at a second location, the method comprising the steps of:

sending a first series of data shuffled according to a first permutation from the shuffler to the deshuffler;

sequentially writing the first series of data into the memory such that data is written into a memory location immediately after that memory location has been read,

sending a second series of data according to an inverse of the first permutation from the shuffler to the deshuffler; and

writing to memory locations defined by the data in the inverse permutation such that data is written into a memory location immediately after that memory location has been read.

8. A method of writing data into a memory having C columns and R rows defining a plurality of memory locations, the method comprising the steps of:

dividing the data into lines wherein each line contains a first length of data;

dividing the lines into subsets each having a second length being smaller that the first length;

writing each subset into a selected row and column range of the memory such that each time a subset is written, the selected row is incremented by a value I.

9. The method of claim 8 wherein I is selected so that each row has data written therein within a minimum selected time interval.

* * *

ABSTRACT

This invention teaches a video line shuffling method wherein video line displacement is variable and controlled depending upon the distortion in a given system. A series of permutations is applied to the original picture such that lines are shuffled in a controlled manner to achieve line displacement within a desired range. Memory requirements are minimized by utilizing a method whereby a single memory has data written into locations which were read from in a previous step. Where DRAM is utilized for the memory, a write method is employed to eliminate the need for strobing the rows and columns DRAM.

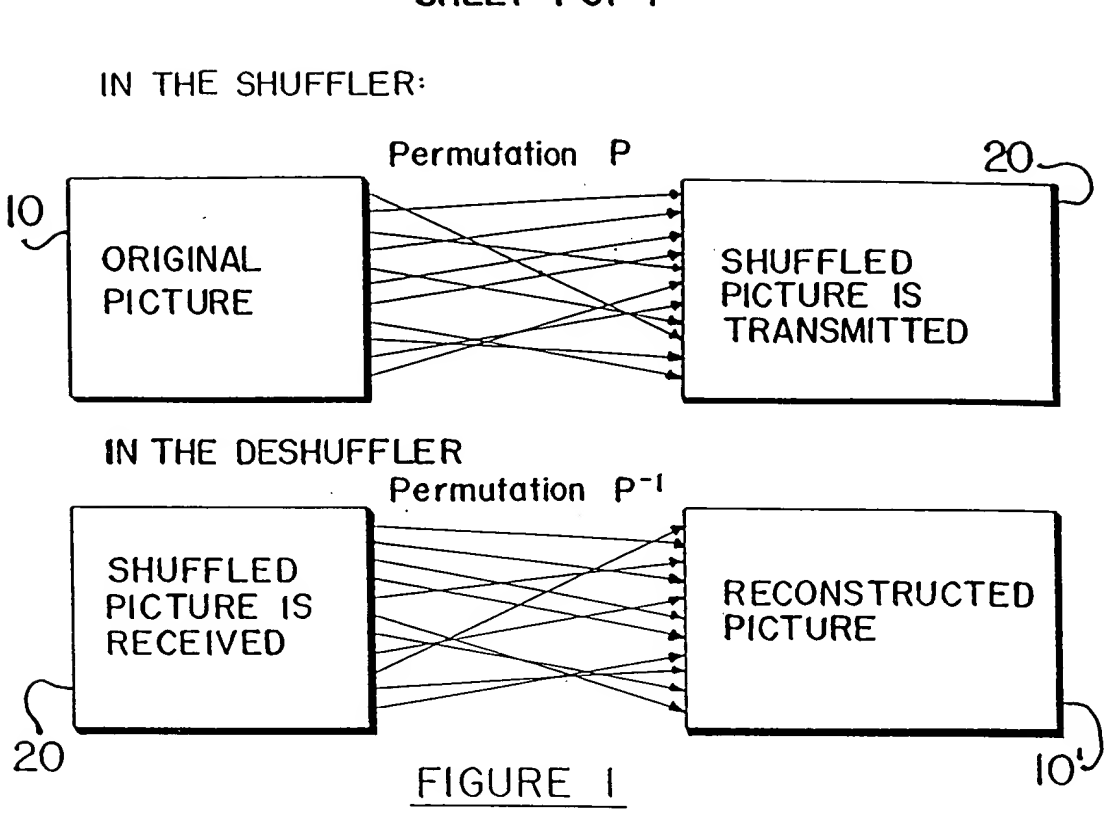
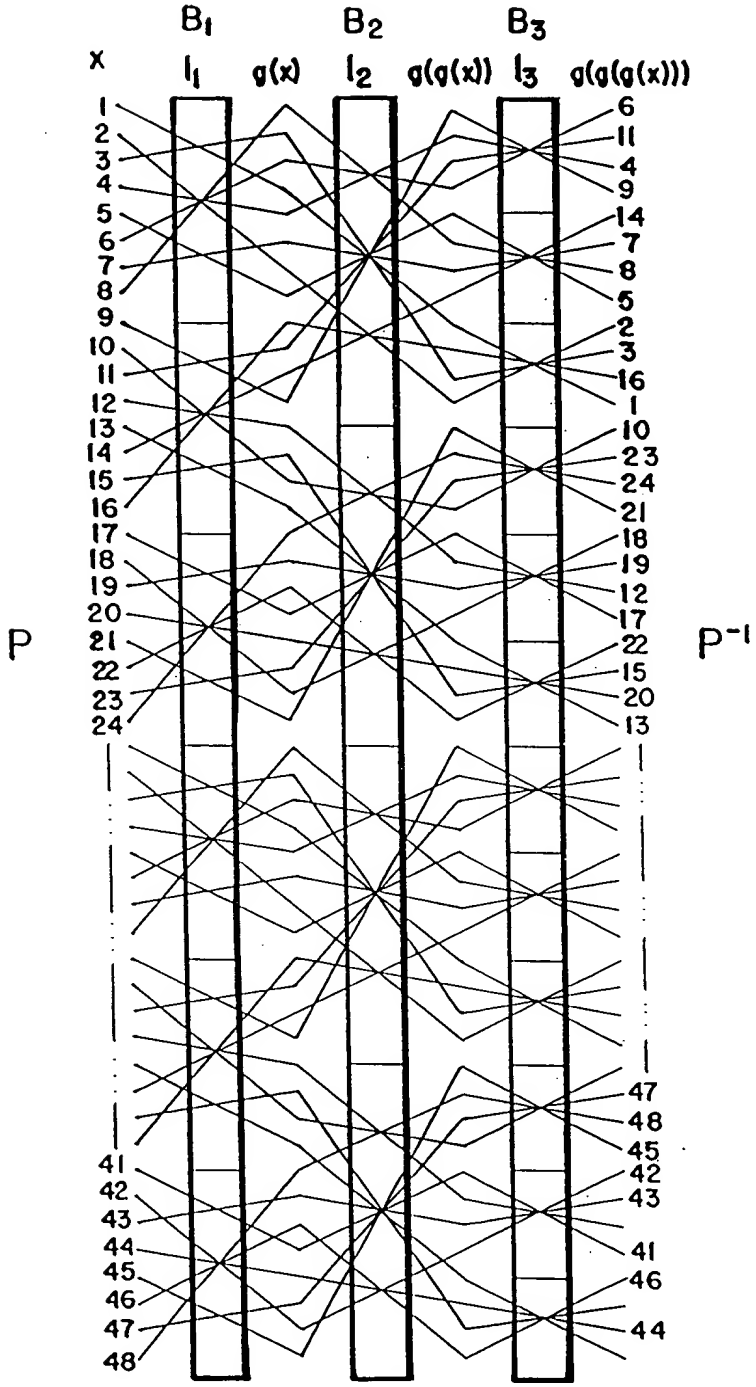

IN THE SHUFFLER:
Permutation P
10
ORIGINAL PICTURE
SHUFFLED PICTURE IS TRANSMITTED
20
IN THE DESHUFFLER
Permutation P^{-1}
SHUFFLED PICTURE IS RECEIVED
20
RECONSTRUCTED PICTURE
10'

FIGURE 1



$g(g(g(x,B_1,I_1),B_2I_2),B_3B_3)$

FIGURE 2

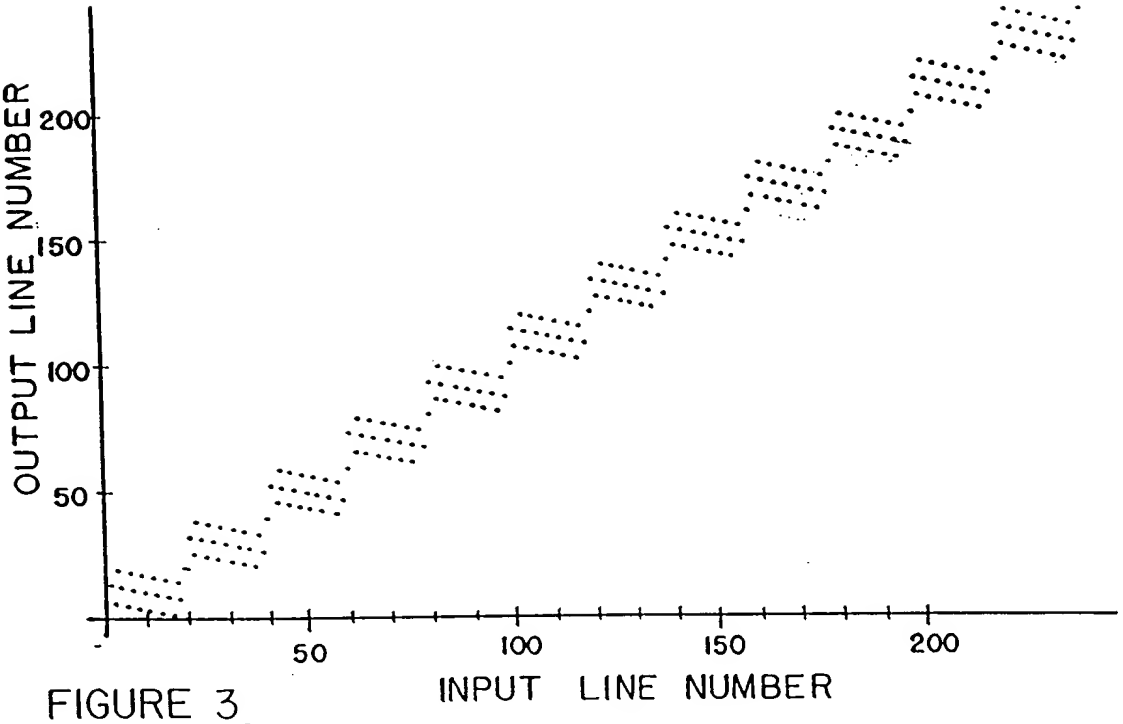


FIGURE 3

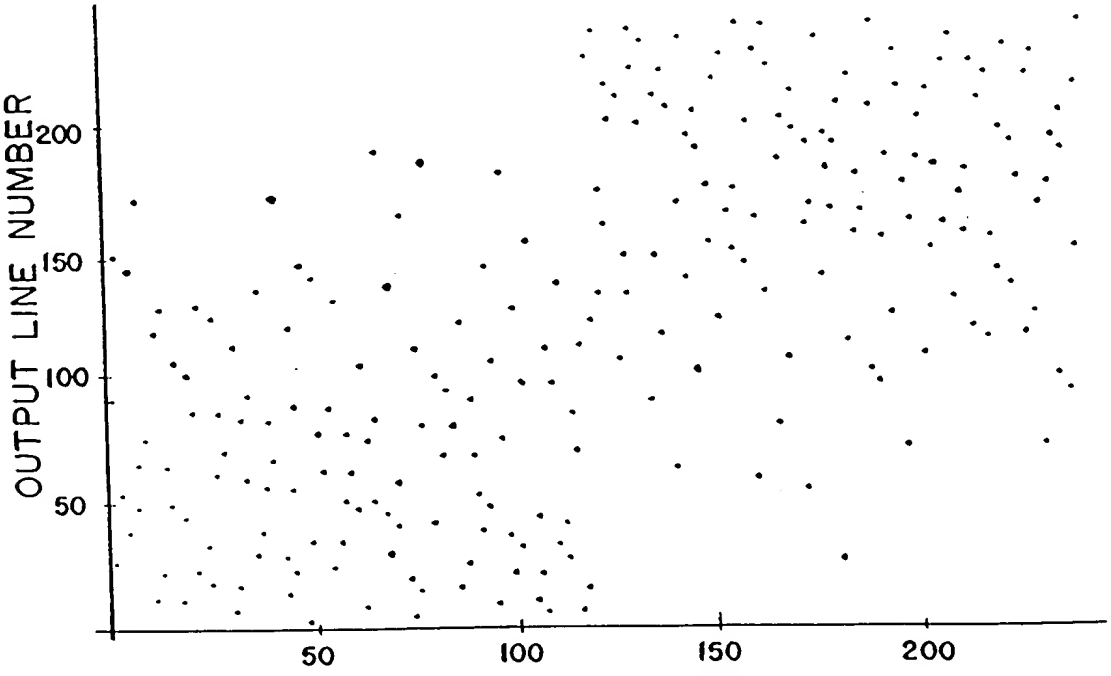


FIGURE 4

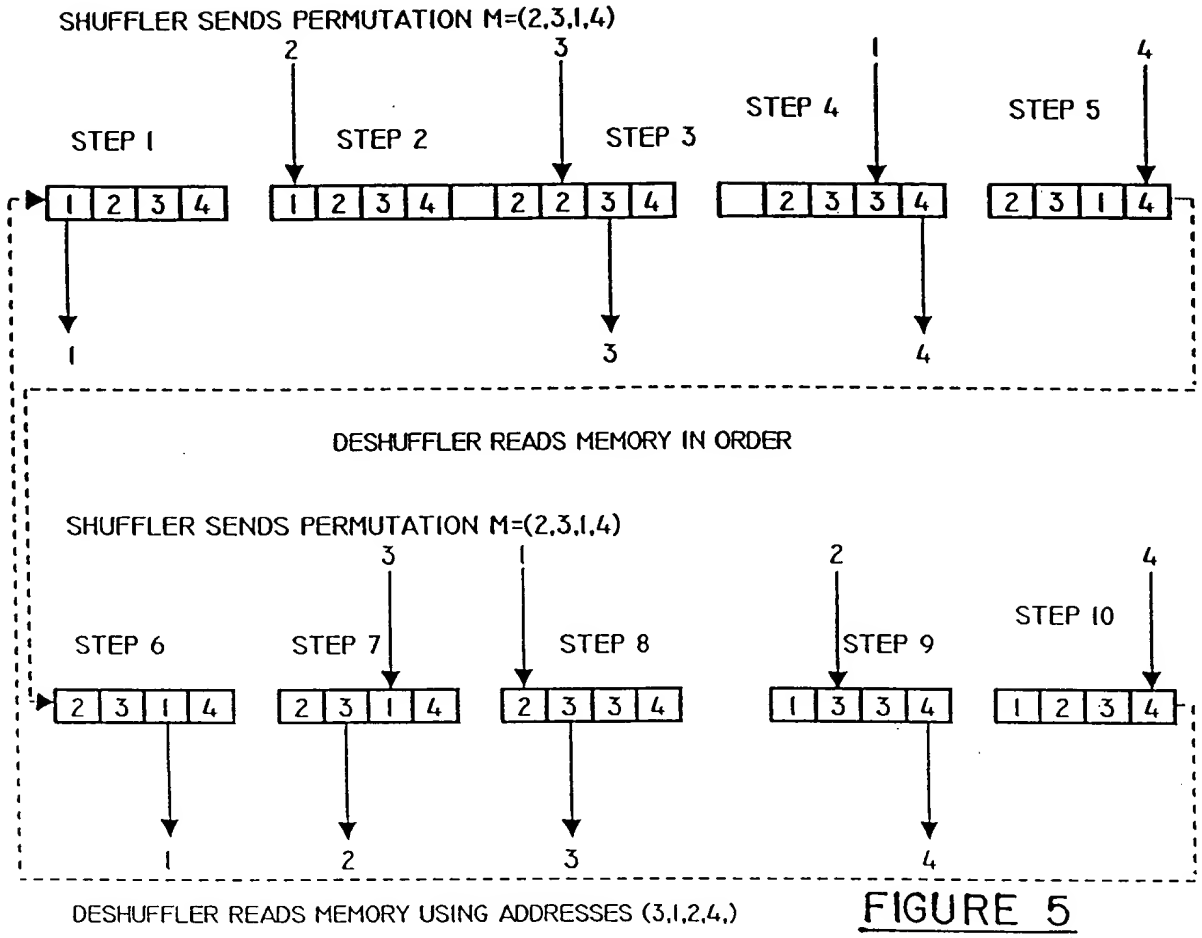


FIGURE 5

VIDEO LINE	ROW DURING SAMPLES							
	0-127	128-255	256-383	384-511	512-639	640-767	768-895	896-908
0	0	64	128	192	256	320	384	448
1	1	65	129	193	257	321	385	449
2	2	66	130	194	258	322	386	450
3	3	67	131	195	259	323	387	451
4	4	68	132	196	260	324	388	452
...	...	...	...	...	...	...	...	...
63	63	127	191	255	319	383	447	511
64	64	128	192	256	320	384	448	0
65	65	129	193	257	321	385	449	1
66	66	130	194	258	322	386	450	2
67	67	131	195	259	323	387	451	3
...	...	...	...	...	...	...	...	...
N	N	(N+64) %512	(N+128) %512	(N+192) %512	(N+256) %512	(N+320) %512	(N+384) %512	(N+448) %512

FIGURE 6

Please type a plus sign (+) inside this box → ☐

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	MOT-D2191
First Named Inventor	Kelly et al.
COMPLETE IF KNOWN	
Application Number	09/787,602
Filing Date	Not Yet Known
Group Art Unit	Not Yet Known
Examiner Name	Not Yet Known

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS

(Title of the Invention)

the specification of which
☐ is attached hereto
OR
☒ was filed on (MM/DD/YYYY) 09/20/1999 as United States Application Number or PCT International Application Number PCT/US99/21666 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)

☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Washington, DC 20231.

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number *(if applicable)*
PCT/US99/21666	09/20/1999	

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☒ Customer Number 24375 → *Place Customer Number Bar Code Label here*

OR

☐ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
Namely, the Attorneys of Volpe and Koenig, P.C.			

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number or Bar Code Label 24375 *OR* ☐ Correspondence address below

Name	VOLPE AND KOENIG, P.C. DEPT MOT				
Address					
Address					
City		State		ZIP	
Country		Telephone		Fax	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Charles P.	Kelly

Inventor's Signature						Date	
Residence: City	The Colony	State	TX	Country	USA	Citizenship	USA
Post Office Address	4905 Colony Blvd. N						
Post Office Address							
City	The Colony	State	TX	ZIP	75056	Country	USA

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 1 of 1

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Douglas N.	Nelson		
Inventor's Signature			**Date**
Residence: City Plano	**State** TX	**Country** USA	**Citizenship** USA
Mailing Address 7001 West Parker			
Mailing Address Apartment 1617			
City Plano	**State** TX	**ZIP** 75093	**Country** USA

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
Mailing Address			
Mailing Address			
City	**State**	**ZIP**	**Country**

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Inventor's Signature			**Date**
Residence: City	**State**	**Country**	**Citizenship**
Mailing Address			
Mailing Address			
City	**State**	**ZIP**	**Country**

Atty. Docket No. MOT-D2191

ASSIGNMENT

WHEREAS, Charles P. Kelly, residing at 4905 Colony Blvd N, The Colony, TX 75056, United States of America; and Douglas N. Nelson, residing at 7001 West Parker, Apartment 1617, Plano, TX 75093, United States of America, both citizens of the United States of America (hereafter jointly and severally referred to as the undersigned), are the inventors of METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS, for which the undersigned have executed an application for United States Letters Patent, U.S. Patent Application No. 09/787,602, which is the U.S. National Phase Application of International Application No. PCT/US99/21666; filed September 20, 1999.

The undersigned hereby authorize assignee or assignee's representative to insert the Application Number and the filing date of this application if they are unknown at the time of execution of this assignment.

AND, WHEREAS, General Instrument Corporation, a Delaware corporation, having its principal place of business at 101 Tournament Drive, Horsham, PA 19044, United States of America (hereafter referred to as the assignee), is desirous of acquiring the entire right, title and interest in said invention, all applications for and all letters patent issued on said invention.

NOW, THEREFORE, in consideration of One Dollar ($1.00), receipt of which is acknowledged by the undersigned, and of other good and valuable consideration, the undersigned, intending to be legally bound, do hereby sell, assign and transfer to the assignee

and assignee's successors, assigns and legal representatives the entire right, title and interest in said invention and all patent applications thereon, including, but not limited to, the application for United States Letters Patent entitled as above, and all divisions and continuations thereof, and in all letters patent, including all reissues thereof, throughout the world, including the right to claim priority under the Paris Convention.

It is agreed that the undersigned shall be legally bound, upon request of the assignee, to supply all information and evidence relating to the making and practice of said invention, to testify in any legal proceeding relating thereto, to execute all instruments proper to patent the invention throughout the world for the benefit of the assignee, and to execute all instruments proper to carry out the intent of this instrument.

The undersigned warrant that the rights and property herein conveyed are free and clear of any encumbrance.

EXECUTED under seal on this _____ day of _____, 2001

at _____.

Witness:

_____ _____

(L.S.) Charles P. Kelly

State of _____

ss.

County of _____

On this __ day of _____, 2001 before me personally appeared Charles P. Kelly, to me known to be the persons described herein and who executed the foregoing instrument, and acknowledged that he executed the same knowingly and willingly and for the purposes therein contained.

Witness my hand and Notarial seal the day and year immediately above written.

_____

Notary Public

My Commission Expires:

EXECUTED under seal on this _____ day of _____, 2001

at _____.

Witness:

_____ _____

(L.S.) Douglas N. Nelson

State of _____

ss.

County of _____

On this __ day of _____, 2001 before me personally appeared Douglas N. Nelson, to me known to be the persons described herein and who executed the foregoing instrument, and acknowledged that he executed the same knowingly and willingly and for the purposes therein contained.

Witness my hand and Notarial seal the day and year immediately above written.

_____

Notary Public

My Commission Expires:

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Volpe and Koenig PC
1617 JFK Blvd
400
Philadelphia, PA 19103

SHIPPER'S FEDEX ACCOUNT NUMBER

FedEx
Federal Express

TO: Mr. Charles P. Kelly (972)219-7998

2184 Brady Drive

Lewisville, TX 75057-

SHIP DATE: 02JAN02
MAN-WGT: 1 LBS

REF: MOT-D2191 DWS/amc

DELIVERY ADDRESS BARCODE (FEDEX-EDR)

CAD # 4729072 **PRIORITY OVERNIGHT** **THU**
A1

TRK # **7917 4502 1279** FORM 0201

Deliver By:
DFW 03JAN02

75057-TX-US
DROP OFF

XM JMDA

Exhibit Q

- Track Shipments
- Alternate Reference Track
- Email Track
- Custom Critical
- Cargo Track
- American Freightways
- Viking Freight

Related Links
- Signature Proof
- My FedEx
- FedEx Wireless Solutions
- Handheld Track
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Detailed Results

Quick Help

Tracking Number	791745021279
Reference Number	MOT-D2191 DWS/AMC
Ship Date	01/02/2002
Delivered To	Recipient
Delivery Location	LEWISVILLE TX
Delivery Date/Time	01/04/2002 12:15
Signed For By	A.MY MCSHEA
Service Type	Priority Letter

Tracking Options
- Obtain a Signature Proof of Delivery
- Email these tracking results to one or more recipients
- Track More Shipments

Scan Activity	Date/Time	Comments
Delivered IRVING TX	01/04/2002 12:15	No signature required - release waiver on file
Delivered IRVING TX	01/04/2002 12:15	No signature required - release waiver on file
On FedEx vehicle for delivery IRVING TX	01/04/2002 08:23	
Package status IRVING TX	01/03/2002 14:13	Package in FedEx location
Delivery attempt IRVING TX	01/03/2002 09:57	Customer not available or Business closed
On FedEx vehicle for delivery IRVING TX	01/03/2002 08:05	
Left FedEx Ramp DALLAS TX	01/03/2002 07:45	
Arrived at FedEx Destination Location IRVING TX	01/03/2002 06:36	
Left FedEx Sort Facility MEMPHIS TN	01/03/2002 05:00	
Left FedEx Sort Facility MEMPHIS TN	01/03/2002 04:38	
Arrived at FedEx Ramp DALLAS TX	01/03/2002 04:11	
Left FedEx Sort Facility MEMPHIS TN	01/03/2002 01:12	
Arrived at Sort Facility MEMPHIS TN	01/02/2002 23:28	

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Enter your email (optional), up to three email addresses as recipients, add your message, and click on **Send Email**.

From

To

To

To

Add a message to this email.

Exhibit R

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FedEx Express
Customer Support
Domestic Trace
3875 Airways Boulevard
Module H, 4th Floor
Memphis, TN 38116

U.S. Mail: PO Box 727
Memphis, TN 38194-4643

Telephone 901-369-3600

FedEx. Express

January 07,2002

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(215) 568-6499

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Our records reflect the following delivery information for the shipment with the tracking number 791745021279. The package was released as authorized by the shipper/recipient.

Delivery Information:

Released By:	A.MY MCSHEA
Delivered to:	2184 BRADY DRIVE
Delivery Date:	January 04, 2002
Delivery Time:	12:15 PM

Shipping Information:

Shipment Reference Information: MOT-D2191 DWS/AMC

Tracking No:	791745021279	Ship Date:	January 02, 2002
Shipper:	AMY MCSHEA VOLPE & KOENIG PC 1617 JFK BLVD STE 400 PHILADELPHIA, PA 191031897 US	Recipient:	MR. CHARLES P. KELLY 2184 BRADY DRIVE LEWISVILLE, TX 75057 US

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MR CHARLES P KELLY
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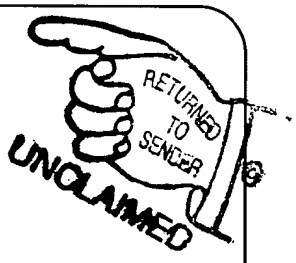
LEWISVILLE TX 75057



WPM

32

P.C.

Exhibit S

United States Postal Service

Request for Delivery Information/Return Receipt After Mailing

RECEIVED AM/PM

JAN 17 2002

VOLPE & KOENIG, P.C.

INSTRUCTIONS FOR USE:

Accepting Office

1. *Internal Use Only.* Help the customer complete Section 2 of this form and carefully compare it to [illegible]. Complete the shaded portions in Section 1.
2. Collect fees if required.
3. Select ONE of the following three options:

   A. ___ If the item was mailed to an office not participating in the new signature capture process (refer to POM Section 619), regardless of the date of mailing, send this entire form, with Sections 1 and 2 completed, to the delivery office.

   B. ___ If the item was mailed before the start of the new signature capture process, send this entire form, with Sections 1 and 2 completed, to the delivery office.

   C. ___ If the item was mailed after the start of the new signature capture process, choose one of the following two options:

   - ☐ If the office has Intranet access, use Intranet to generate the request, then discard the form. If no record is found, manually complete section three and mail to customer.
   - ☐ If the office does not have Intranet access, send this entire form, with Sections 1 and 2 completed, to a designated inquiry location.

Delivery Office - Use Only for Manually Filed Delivery Record Inquiries (3A or 3B checked above)

1. If the fee is not attached or the form is not postmarked to show that the fee was paid at the time of the mailing, return this form to the accepting office.
2. Complete the shaded items in Section 3 below. Enter the delivery information or indicate the reason for no information.
3. After completion, detach and insert the bottom portion of this document in an envelope addressed to the requestor and deposit it in the mailstream. Discard the remaining portion.

Section 1

Accepting Office: Postmark if Return Receipt fee was paid at time of mailing.

PENN CENTER POSTAL STORE PHILADELPHIA PA 19102

☑ Return Receipt fee WAS paid at time of mailing. (Customer has provided receipt. Postmark where indicated at left.)

☐ Return Receipt fee WAS NOT paid at time of mailing. (Attach fee below.)

Attach fee here if applicable

Accepting Office City/State/ZIP Code: Penn Center Philadelphia PA 19102

Delivery Office/Manual Inquiries: Detach at dotted line and return bottom portion to customer when inquiry is resolved - discard remainder of form.

Electronic Inquiries: Generate request from Intranet and discard the entire form.

Section 2

A. TYPE OF SERVICE

- ☑ Certified
- ☐ COD
- ☐ Express Mail
- ☐ Numbered Insured
- ☐ Registered
- ☐ Return Receipt for Merchandise

C. ARTICLE INFORMATION

Article Number: 7000 1670 0011 8618 1407

Mailing Date (mm/dd/yy): 12/18/01

B. ARTICLE ADDRESSED TO

Addressee Name: Charles Kelly

Addressee Address: 2484 BRADY DRIVE

(No., Street, Apt./Ste. No.)

LEWISVILLE TX 75057

(City, State, ZIP Code)

D. REQUESTOR

Requestor Name: VOLPE-KOENIG

Requestor Address: 1617 JFK BLVD STE 400

(No., Street, Apt./Ste. No.)

PHILA PA 19103

(City, State, ZIP Code)

FAX Number *(Complete ONLY if an electronic inquiry - include area code)*

Section 3

For Delivery Office Use Only

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- ☐ Record not found
- ☐ Forwarded (date: _____)
- ☑ Returned (date: 1-9-02)

Delivered to the following individual, company or organization

Delivery Date: Unclaimed

Delivery Address (if different from address in section 2B):

Delivery Office Postmark: LEWISVILLE TX 75067 JAN 15 AM USPS